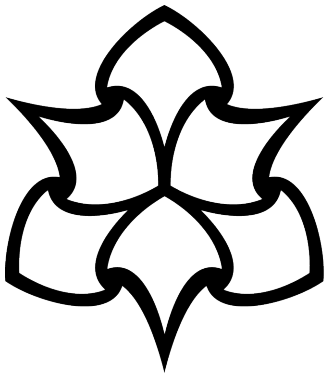

Questioning the social and ethical implications of autonomous vehicle technologies on professional drivers

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Abstract: The haulage industry and its drivers have been using vehicles with the first generation of advanced driver assistance systems (ADAS) for the last three years, gaining a wealth of knowledge and experience in the millions of kilometres driven. Despite this, there has been little research to understand how these technologies have been received by HGV drivers. To date, designers have typically focused on the control protocols that will govern decision-making and the potential gains in efficiency and social mobility that such technologies may unlock (Milakis, van Arem & van Wee, 2017). By contrast, this paper will present findings from a qualitative study conducted with HGV drivers to examine their overlooked role as the pioneers of driverless technologies. This paper will explore the value of the experiences of HGV drivers and the real-world opportunities and challenges that may be presented through the proposed introduction of autonomous vehicles.

Keywords: Driverless, Autonomous, Trucks, Ethical, Social

1. Introduction

1.1 Background and aims

Future visions of autonomous vehicles produced by academics, technology and automotive giants tend to project a frictionless world where machines move seamlessly through our cities with no congestion or ambiguity as to their role and without any consideration as to their relationships to the inhabitants of those cities (Deloitte, 2018). Yet it seems unlikely that the algorithms that underpin driverless technologies will simply replace humans without meeting challenges when faced with the 'messiness' of existing infrastructure and working practices.

Since the 1st November 2015 HGV drivers has been using advanced driver assistance systems (ADAS) in their day to day lives. Governed by legislation, new Euro 6 HGVs are equipped with emergency brake assist (EBA) and lane departure warning systems (LDW). These technologies are often accompanied by adaptive cruise control (ACC) systems that maintain a specified distance to the vehicle in front. Truck drivers travel around 100,000 km per year, this is compared to car drivers, who cover approximately 12,500 km per year (RAC Foundation, 2018). To put this into perspective, it

would take the average car driver around eight years to acquire the experiences that a HGV driver obtains in a single year. This means that some HGV drivers have the equivalent of 24 additional years of using ADAS when compared to the average car driver. It is for these reasons that this study has chosen to engage with HGV drivers as the pioneers of early driverless technologies, a group which is overlooked and undervalued for their knowledge.

The failure of designers to consider this critical group of drivers is evidenced in a recent BBC article discussing driverless mobility which asserts "you have (probably) already bought your last car" and "human drivers banned" (Rowlatt, 2018). It seems highly unlikely that hauliers would dispense of their trucks. If no drivers will be allowed, we would assume that the haulage industry would also be investing in the same technology. Yet without clear benefits to the haulage industry, why would companies invest in driverless technologies? Haulage makes up an essential part of the way in which we live our lives and so to ignore drivers in this industry, negates the fact that roads contribute economically and socially to our entire global system of operation. By engaging with this marginalised group, designers have the opportunity to highlight some of the design challenges and opportunities of driverless vehicles, based on the millions of miles of experiences that HGV drivers have. This paper will discuss some of these challenges and opportunities through the experiences of drivers.

1.2 Methods

This paper presents findings from a qualitative study which used two methods to gather data from HGV drivers, owners and operators. Initially, a widely used internet forum TruckNet was used to post scoping questions which were then followed up with more in-depth questions to encourage discussion. For ethical reasons no demographic data was asked, other than the type of work the participant did for a living. These findings were analysed to elicit an understanding about the current confidence in ADAS and how the future of HGV driving was perceived. Through identifying emerging topics and themes, questions were developed that could help the researcher explore the issues in greater depth using face to face interviews.

The face to face interviews were intended to develop a deeper understanding of how the industry has changed as a result of technology, while thinking about the social and ethical implications that driverless technologies may have in the near future. This research adopted ethnographic principles in that drivers were interviewed within their field of work at Haywood truck stop by a researcher who had previous experience of driving as part of their occupation. An interview schedule was used as a guide, but the interviewer tried to maintain a relaxed informal discussion through which data could be elicited. The pooled data from both the forums and the face to face interviews were analysed using thematic analysis (Braun & Clarke, 2014). This method was used to elicit a new understanding of early driverless technologies. This study obtained ethics approval from Lancaster University FASS-LUMS ethics committee #FL17161. Study information and the right to withdraw data was provided to all participants. Participants gave either verbal or written consent to taking part in this study.

2. Findings

A total of 25 participants responded to questions on the Trucknet forum, generating around 50,000 words of data. A further eight participants undertook face to face interviews at Haywood Truck stop over four sessions, averaging approximately 90 minutes per interview. Thematic analysis of the combined dataset led to the identification of five key themes: *Technology, Change, Relationships, Respect and Future.* Quotes from participants (p.#) are given to support the themes.

2.1 Technology

Current perceptions of ADAS technologies
Following discussions with drivers, systems such as EBA, LDW and ACC appear to be far from foolproof. As a result, the drivers who are using these systems find it hard to believe that Level 4 (where the driver requires no input within predetermined conditions) or Level 5 autonomy (where a driver is never needed) (SAE International, 2016) could exist in their lifetime. One of the commonly reported issues was the interaction between automation and other human drivers. When approaching an off ramp, it is common for car drivers leaving the main carriageway to slip in-between HGVs. Drivers report that EBA systems have a tendency to emergency brake, potentially damaging their load and causing the driver to be reprimanded for heavy braking, which has been recorded by the tracking systems. This is something that drivers report as unnecessary and demonstrates that the systems are not able to read the road and other drivers appropriately. As a result, many drivers turn off the systems when driving in cities or on busy roads. Drivers also reported false positives, including *"EBS which applies the brakes for no good reason now and again"* (p.1).

Training or lack thereof
Drivers expressed concerns about how vehicle technologies were being introduced. No participant had received specific training in how to use EBA and LDW. The driver Certificate of Professional Competence (CPC) was described as a *"load of rubbish… After 40 years, what am I going to learn in a classroom"* (p.2). CPC was described as badly thought through and implemented, only covering subjects that drivers understand well. There was an opinion that "*CPC…should incorporate the technology… I wasn't shown when I was given my new Volvo*" (p.3). As of October 2018, the Driver CPC Syllabus states nothing about the use of new technologies and driver assist (Driver and Vehicle Standards Agency, 2018). This means that drivers have had no formal training about how to use EBA and LDW.

Robustness and maintenance
Concerns about the robustness of these systems were also raised. The industry sees HGVs as industrial bits of equipment which are used and abused and regularly covered in grime. Drivers indicated that technology and their sensors are proving susceptible to failure within a haulage environment. This opinion was echoed by a mechanic, who expressed concerns about the time it would take to repair such systems which had become damaged, saying that "*the most difficult fault to diagnose is an intermittent electrical issue.*" (p.4).

Trucks
On the other hand, drivers commended the way in which the comfort of trucks had improved over the years. They described trucks as *"easier to drive"* (p.4), *"very comfortable"* (p.5) enabling drivers to sleep well and make their own food. In fact, drivers often expressed the view that trucks needed no further improvement; it was the rest of the industry that needed to improve.

2.2 Change

Responsibility - driver or machine?
One of the greatest concerns raised was how *"the driver is responsible for a vehicle that he has no control of"* (p.6). Anti-lock braking systems (ABS) were viewed positively, as the driver was viewed to remain as the decision maker. EBA was seen differently, as the decision is led by a computer and not the driver. This raised concerns about who is responsible for the vehicle as the truck is able to make decisions regardless of the driver, yet currently the law states that the driver is fully responsible for every aspect of the vehicle.

Challenges of road infrastructure
The UK's road infrastructure frequently challenges drivers. The design of the road network means *"mounting pavements for all sorts of reasons, this is of course a routine issue. So is deviating from lanes and otherwise negotiating road space with other traffic"* (p.7). Most drivers expressed concern about how a driverless vehicle would contend with this and if a driverless vehicle would ever be able to bend the rules of the road. Deviation from the rules were deemed essential in cases such as when vehicles needed to perform awkward manoeuvres. In these cases, drivers reported the need to communicate with other road users, for example by using the vehicle's hazard lights, or by using hand signals, or even talking to other drivers. It appears unclear how driverless vehicles could communicate with other drivers or be communicated to by humans.

Disorganisation through technology
Mobile phones, trackers and despatch systems were seen as technologies that have had major impacts on the industry and had become the facilitators to what drivers described as the constant *"push"* to be quicker and do more. While not universally disliked, such systems had removed some of the self-reliance drivers once had, which was one of the aspects they used to enjoy most about the job. Prior to the introduction of such technologies, drivers spoke of the need to plan days in advance, checking in by pay phone once the jobs were complete. By contrast, today, drivers report that *"firms don't really seem to plan movements more than five minutes ahead"* (p.7). This shift is seen by drivers as a level of disorganisation which mean you have no ability to plan your life, "*you never know when you are going to be home"* (p.2). This has had repercussions for drivers' family and social lives, with drivers expressing that *"you miss your family and children growing up"* (p.8). Despite the changes that technology has had, drivers held the industry responsible as opposed to the technology.

The sweating of an industry
The haulage industry was often described as a *"sweated trade with poor conditions" (p.7)*. Gains in efficiency were often seen as a way of driving down prices and were rarely implemented for the benefit of drivers. Haulage firms are still predominantly family run businesses that have to be competitive and are at the mercy of large multi-national customers. The industry reports that smaller haulage firms are also competing with the few large national hauliers who operate on economies of scale. Drivers feel that no one person has overview of the transport industry and that decisions being made by large multi-national customers are adversely affecting them. This belief is perpetuated by the fact that drivers feel that they lack representation within the industry. There has always been a lack of union representation according to drivers, however in the past, haulage firms were often run by drivers and so they felt that they were represented and heard by their bosses. Today it is common for general haulage to be run by *"classroom transport managers"* (p.9) who have never experienced professional driving. As a result, drivers feel that genuine complaints and concerns are sometimes just met with, "*they're just complaining again*" (p.5). Drivers also feel that there is an attitude of comply or leave within the industry, as drivers feel that they are easily replaced.

2.3 Relationships

Social change through policy
Participants admitted, that HGV drivers are often "loners", but that is by choice and does not represent all drivers. Drivers interviewed in this study, were keen and appreciative of the opportunity to talk to someone. Drivers' social interactions have changed dramatically over the years. Drivers reported the first major change being the introduction of sleeper cabs in the 1970s. Initially intended for long distance work across the iron curtain, these trucks soon became the norm. Before this, drivers used bunk houses and slept in dorms. Although not overly liked at the time, these bunk houses were actually a hive of social activity with drivers sitting together to eat and chat. Because of the routines at the time, drivers used to get to know each other, reporting a *"real…camaraderie…we*

used to all sit together" (p.9). Although these sleeper cabs were the start of a major social change, they were not singularly responsible. Most towns had recognised lorry parks for overnighting, usually the town car park would become a lorry park at night. Those who wanted to, could get out of their cabs and go to the pubs to have dinner and chat with other drivers and locals. However, "*gradually the councils have banned lorries from these parks"* (p.*1)*. Trucks were slowly pushed further and further away from towns, restricted to major roads, out of town truck parks and lay-bys where it is near impossible to conduct any sort of social exchange.

Technology as a barrier/facilitator to social interaction
With increasing levels of automation, drivers reported a struggle to find opportunity to have conversations. Examples like automated fuel pumps and in-cab telemetrics mean that drivers often go long periods without talking to anyone. Technologies have also meant that when drivers are out of their cabs, they keep their heads down, looking at a mobile phone or tablet. Technology is also providing employers oversight of drivers' actions, generating tensions within the industry. Employers, report that tracking in particular, is being forced upon them by the customers, while drivers often report that it is a way of keeping continual observation over drivers. Some drivers felt that their employers used such systems in a responsible way, offering bonuses for good driving and only using the data in the event of an incident, to the benefit of both the driver and employer. Others perceived these technologies more negatively, believing the data to be used to continually evaluate performance and *"push, all the time"* (p.3).

Drivers viewed technologies as having some positive impacts on their working lives. Truck driving has always been a job which has taken drivers away from home and at one time there was little to overcome the distance. Today with phone, video calling, email and messaging services, drivers feel more able to remain connected to home than ever before.

2.4 Respect

Industry - please can I use the toilet?
Professional drivers have raised concerns about how changes in the industry have had a detrimental effect on the work satisfaction of drivers. One factor which was raised more than any other was respect. "*Money and respect is what is needed. But it's mainly respect*" (p.3). This is an underlying problem which at times boils down to something as simple as *"people don't say please and thank you"* (p.3). Drivers reported that it was common to be left in a room or confined to the truck's cab while the truck is being unloaded. If the driver was lucky, *"there may be a coffee machine, there may be a toilet and that's about it"* (p.2). All of the drivers could recall times when they had not been allowed to use the toilet when visiting customer premises. In fact, this has become such an issue across the industry that the HSE (Health and Safety Executive) has waded in, reminding companies including major UK high street retailers, such as John Lewis and Boots, of their legal responsibilities (Commercialmotor.com, 2018). Drivers understandably say that this kind of treatment makes them feel unwanted and viewed as second-class citizens.

HGV Infrastructure "a national scandal" (p.1)
The lack of infrastructure and the resultant impact of drivers having to stay in lay-bys with no facilities was regarded by drivers as a disgraceful situation. This view was not just predicated by the lack of facilities, but also by the fact that lots of hauliers simply will not pay for the drivers to stop in truck stops or services. When drivers did reach dedicated spaces, many felt they did not fare much better with motorway services bearing the brunt of the criticism. Services are expensive, and the quality of the facilities are poor. The food is often expensive, of poor quality and there are few healthy options. But what appeared most annoying for drivers was the lack of security and services. Drivers reported, *"there is so much vehicle theft and thieving… you're on pins all night"* (p.8). This was seen as a given when parking in a lay by, but drivers questioned what they were paying for when

they parked in services. Truck stops fare much better, but there was still a concern about safety. One parked up young driver who had to keep the vehicle secure said *"I got a message to stay out, when I was on my way back... I could walk home from here"* (p.10). This again raises concerns for truck drivers in the way they are respected. There are few jobs that would expect employees to work all day and then do a second job overnight as a security guard.

Technology gone too far?
One of the latest debates is about cameras in trucks. Trucks can now live-stream footage from both road facing and in-cab facing cameras. Forward facing cameras appear to be widely accepted as a method of protecting drivers from scams. *"But inward facing cameras are a total invasion of privacy"* (p.5). Drivers see any inwards facing cameras as an invasion of their privacy, supporting an atmosphere in which drivers feel that they cannot be trusted and have to be continually monitored.

2.5 Future

The potential introduction of driverless technologies was perceived to only worsen a job that has become boring, deskilled, undervalued and unappreciated. The fear was, that the job role would move from a position of some responsibility to one in which drivers are only there to occasionally negotiate poor infrastructure. Vehicles are not far from being able to self-drive down motorways, but drivers felt that full autonomy would not be possible within the foreseeable future without a human available to take over instantly when required.

Autonomy vs infrastructure
Drivers felt that road infrastructure such as markings and road surfaces are simply not defined tightly enough for driverless vehicles to successful operate. This view is supported by Nitsche, Mocanu & Reinthaler, (2014) who conducted a survey of 54 international experts, many raising similar issues to that of the participants of this study. Drivers believed that it would be possible to have autonomous trucks *"If depots are on a motorway with a slip road, automation could have its role"* (p.11). They did not believe that an autonomous vehicle would be able to contend with the current state of roads, with how much ambiguity there is surrounding markings and signs. Drivers doubted that autonomous trucks would ever exist outside of the major road networks. This was mainly attributed to the inadequate nature of non-major roads. Drivers reported that *"deviating from lanes and otherwise negotiating road space with other traffic, is commonplace"* (p.7). They appeared unconvinced that a driverless truck would ever be able to make such decisions.

Communication – syncing drivers and vehicles
Participants raised concerns about the way in which driven and driverless vehicles could be communicated with. Drivers talked about the frequent need to visually communicate with other drivers, in order to allow a HGV the space to perform a manoeuvre. It is unclear how such subtle communication could be performed in a world where one or both parties were driverless. It is quite conceivable that human drivers could manipulate an autonomous vehicle knowing that it would always give way. There was a feeling that until machines had consistently proven their ability to drive as well as, or better than humans, then we should not be considering autonomous vehicles for road use.

Currently we are seeing a situation where the duty of driving is being shared between the machine and human. Looking at the next generation of ADAS, the driver still remains ultimately responsible for the actions of the vehicle. This renders the driver as an observer who drives when the machine cannot. As previously mentioned, this raises major concerns about the attention of the driver and the ability of an observer to intervene effectively in an emergency. This form of relationship already exists between a pilot and a plane, but when this analogy is proposed to drivers, they immediately

identified a difference in the response times required. A plane at altitude gives a pilot seconds to respond, where as a driver at 55mph may only have milliseconds to avert an accident.

Skill and knowledge – old and young drivers
Drivers raised concerns about how skills and knowledge will be retained in the industry. Currently in the UK, the average age of a HGV driver is around fifty (Health and Safety Executive, 2017). Despite government scheme to increase the number of young drivers there is currently still a shortage, *"Young drivers just say this isn't for me."* (p.2). The participants of this study also expressed concern about how young drivers were being introduced to the industry. With learners using the latest technologies as part of their test, including satellite navigation, and the latest trucks with automatic gear boxes and driver aids, there was a worry that new drivers would unduly trust and embrace these systems. Older drivers reported that satellite navigation had been a prime example of this, where young drivers believed and trusted in a technology. Drivers argued that technology rarely contains local knowledge. Drivers recalled conversations that they have had with younger drivers telling them not to use the navigation on a particular drop. Regardless of this, they had used their navigation and ended up getting stuck. There was a feeling amongst drivers that a reliance on technology was starting to creep in, leading to a deskilling of the workforce. With many drivers near to retirement, there was a concern that the knowledge they possessed would be lost to technology.

3. Discussion

These findings paint a bleak picture of the current state of driving within the haulage industry. The advancements being made in autonomous technologies appear not to be based on consultation with drivers, especially HGV drivers, who are at the forefront as users of technology. This underlines a serious oversight as to the design and development of driver technologies. As the pioneers of driver assisted technologies, HGV drivers are raising real world concerns about how these technologies may operate in the future. There is a consensus among drivers that major social change is needed to implement driverless technologies, but this does not mean that there are not real opportunities for users. It is the role of designers to test, understand and examine where these opportunities may lie and how we can inform the future of autonomous vehicles through the early real-world experiences of HGV drivers.

Designers of driverless vehicles have a real challenge to overcome if the technology is to be accepted by drivers. To date, early technologies have not performed as advertised or expected, particularly in their ability to understand and behave like humans. This has resulted in a lack of confidence that driverless technologies could ever be trusted to operate without human oversight. This opinion is not just held by the early adopters but is also shared by drivers in general. A recent study performed by DirectLine Group (2018) indicated that 67% of drivers would prefer to remain in control and that only 18% of people believed that computers were able to make better decisions than humans. Designers of driverless vehicles need to address the issue of acceptability as a result of current experience but also the issue of preference. These issues can only be addressed by designers being collectively involved in understanding real-world limitations of early driverless technologies. Through a shared process of development, drivers' expectations can be managed and collective goals set for the future. Driver CPC is an opportunity which already has a structure in which designers and developers could develop a forum for collective learning and information sharing about how these early technologies need to be developed.

In the immediate future, it is highly unlikely that drivers will be removed from the cab of trucks, due to the requirement for them to negotiate inadequate infrastructure and perform other duties. It is unlikely that the responsibility for the loading and unloading of trucks will be passed to an unknown third party. Also, if drivers are removed, what is to stop criminals placing cones in the road to stop a

truck and unload it before removing the cones and sending it on its way? Despite this, there is an ambition to develop vehicles in which humans are expected to take a back seat to machines (Sparrow & Howard, 2017). Existing concerns about concentration are only going to become more topical as ADAS becomes prevalent. Currently we are rapidly moving towards a situation where drivers are quickly becoming the observer or overseer for vehicles. The consensus from current experiences is that this observer role will lead to boredom and the task becoming less rewarding. Designers must consider that if humans are to be retained, which seems to be the only option in the immediate future without major infrastructural change, then the human machine relationship must be active, as opposed to the passive relationship which we are seeing emerge. For the job to remain rewarding and practicable, the driver must remain involved in the act of driving and most importantly the decision making. Without this, it becomes questionable whether a human would be able to effectively respond to an emergency if required.

While it may be theoretically possible for the current vision of driverless vehicles to operate without human assistance in the near future, if humans are to be retained in cabs, we need to question if driverless vehicles are actually desirable. Within limited applications, such as moving vehicles in areas in which humans are not permitted for safety reasons, there are real benefits to fully autonomous trucks. In these type of scenarios, driverless trucks could free drivers from being locked in a room with no facilities to do what they enjoy; to drive on roads with other humans, moving goods. However, this represents only a small part of the way in which trucks are used and so as designers we must understand that there is not a one size fits all, which we are currently seeing in the development of driverless vehicles. Designers must begin to understand the complexities and differing requirements within the transport industry, rather than the pursuit of advancement in technology for the sake of advancement.

Without driverless vehicles being designed to deliver meaningful benefits to both drivers and hauliers, autonomous vehicles are likely to be challenged by issues of acceptability. This is evidenced in the findings of this study that drivers and some of the owner operators are questioning who the beneficiary of driverless technologies are. Designers have failed to represent the value of technologies such as tracking which is commonly imposed by the customer and EBA, LDW, ACC which have been imposed by legislation. The findings from this study suggest that technology imposed without shared objectives is often disliked and seen as for the benefit of others. This scepticism is already emerging in the discourse of drivers when discussing driverless technologies. For example, ABS was developed to help solve an issue of drivers controlling vehicles under heavy braking. Conversely, drivers today are not reporting that they struggle to keep a vehicle in its lane, as a result, they challenge who lane departure systems are truly for? These opinions are entirely understandable when you consider that no consultation, or shared objectives have been discussed and it is extremely hard for drivers to recognise how current visions of the future address the problems they face on a day-to-day basis.

Despite the distrust among drivers evidenced here, increased automation could have benefits within the haulage industry for end users. Rather than the development of driverless vehicles in which the objective is the removal of the driver, there are opportunities to develop mutually beneficial relationships in which collectively the vehicle and human add to each other's capabilities. Both humans and machines have their weakness, by working together in a collective capacity it is possible to create an environment in which each party can learn from each other, creating a higher standard of driving. If in the future drivers are to be retained, then we need to question who in the relationship becomes the observer. The current trajectory lacks sense when you consider that humans get bored and as a result, will find entertainment in doing things other than observing. Machines have no such problems and will diligently observe with zero interruption. It is the vehicle that should be viewed as the observer, which could actively inform the driver of hazards and local

information. Vehicles could also share data with other vehicles, forming a local network of information, which is relayed to other drivers, helping to ensure that knowledge is not lost.

3.1 Further Work

Further work will use illustrations and comics as a method to represent and explore the findings to date. The comics will depict day to day scenarios of drivers engaging with future technologies, enabling all stakeholders to engage in common discussion about the future of driverless technologies (Hatfield, 2005). These images will be used as part of a model, in which participants can rate and comment on aspects of the scenarios.

The findings of this research demonstrate that early adopters of ADAS represent a key source of information, providing insight into how autonomous technologies will be received and implemented in the future. Further work by designers should consider drawing on the real-world experiences of this neglected group to test and explore the realities of driverless cities.

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